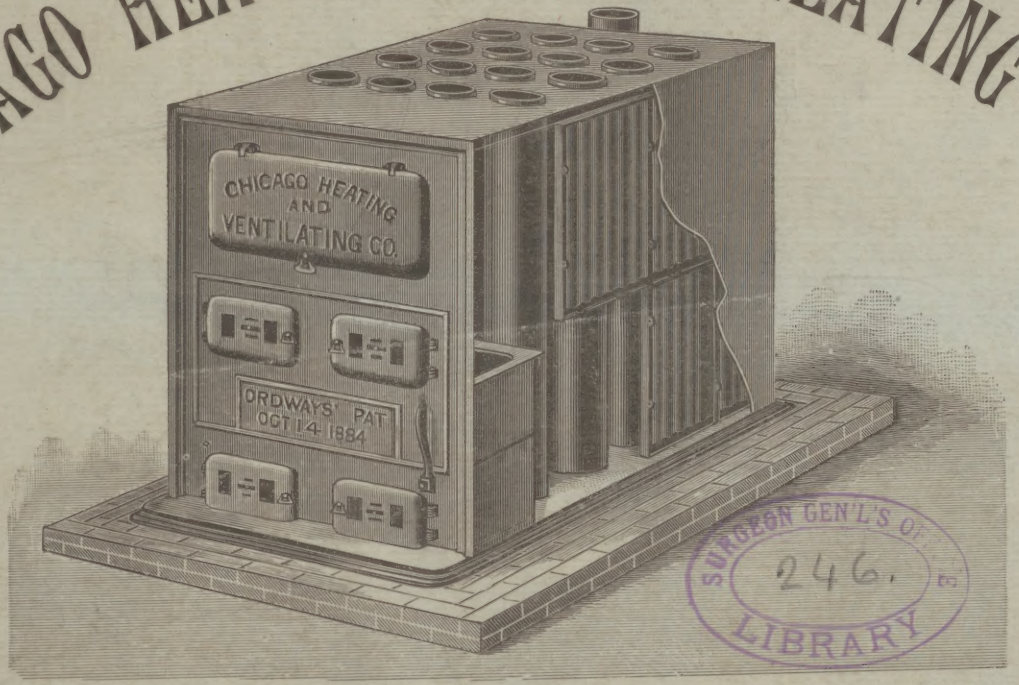
THE CHICAGO HEATING AND VENTILATING COMPANY,



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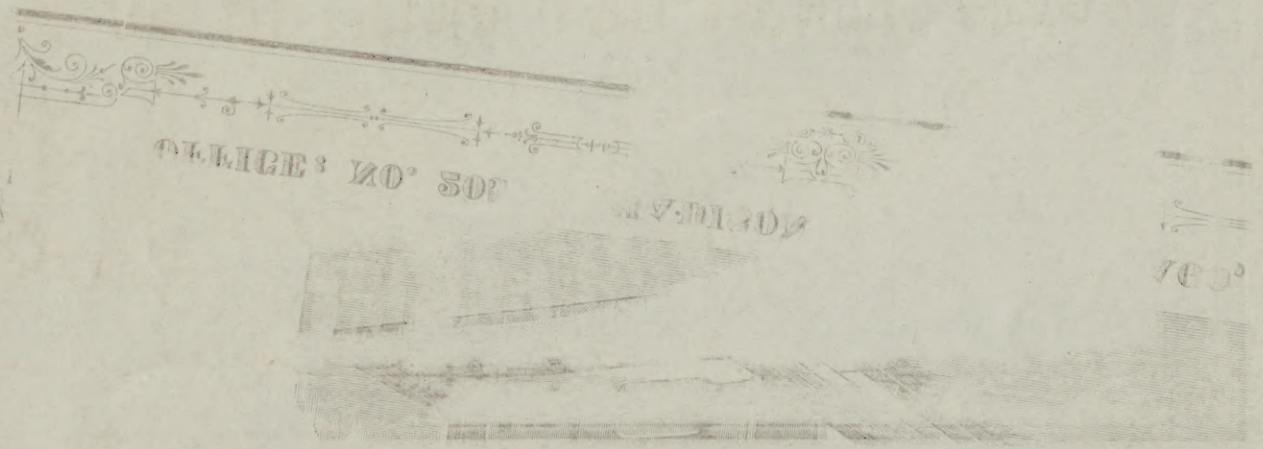

USEFUL INFORMATION

PERTAINING TO THE

TRUE SYSTEM OF HEATING AND VENTILATION

OF BUILDINGS,

INVENTED BY IRA J. ORDWAY.

FURNACES AND VENTILATING APPARATUS,

MANUFACTURED BY THE

CHICAGO HEATING AND VENTILATING COMPANY.

OCTOBER, 1885.

No. 205 W. Madison Street, Chicago, Illinois.

The Chicago Heating and Ventilating Company.

IRA J. ORDWAY, *President.* O. H. MANNING, *Secretary.*

A. J. STONE, *Treasurer.*

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N. O. Moore, Printer, Chicago.

PREFACE.

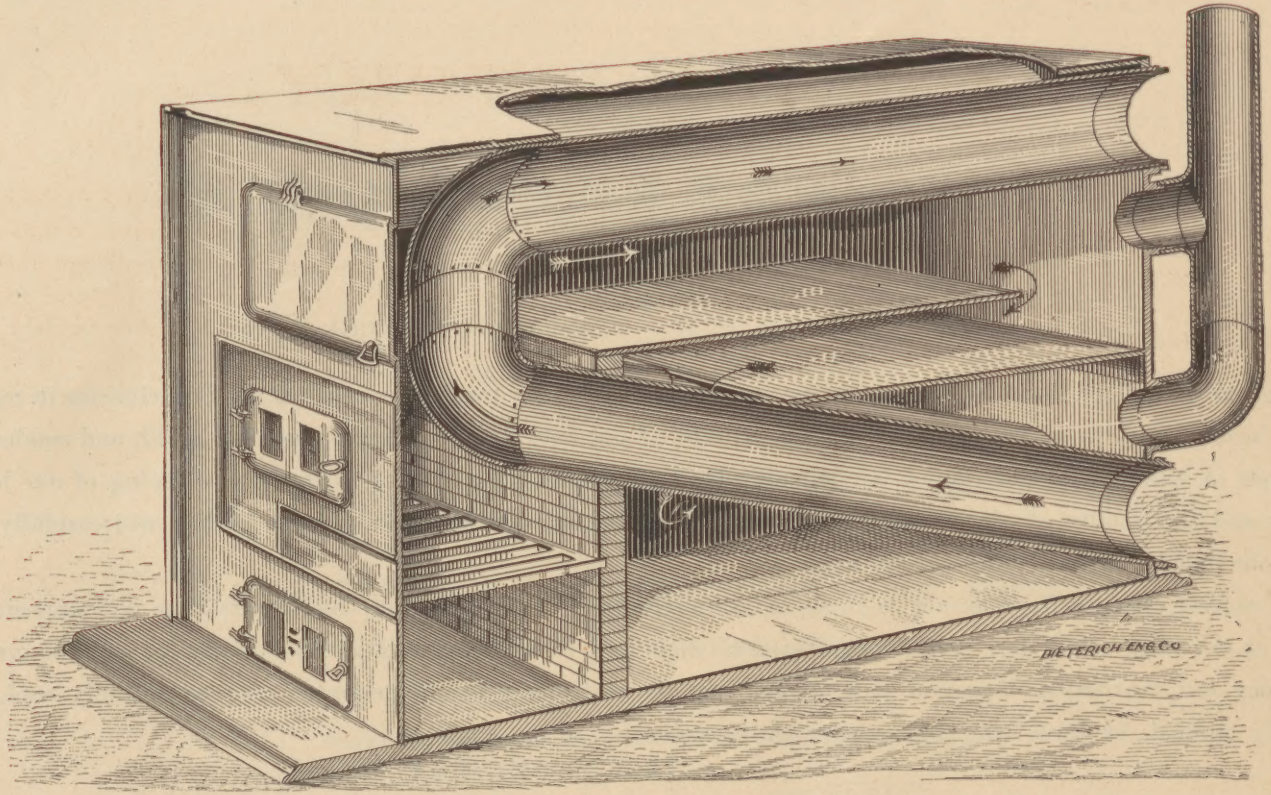
A careful perusal of the following pages, we trust, will enable the reader to arrive at such conclusions in regard to the heating and the ventilation of buildings, as will, if put into practice, greatly promote health and comfort.

Persons of sound judgment cannot fail to understand the natural laws which govern the warming of our habitations, and the quality of air necessary to sustain life in the fullness of all its powers, if they will carefully examine the subject, and correctly reason upon it.

Such radical changes from former methods as are advocated in this work, may receive criticism and opposition; but if, at the same time, they lead to investigation, there will be obtained a clearer knowledge of the true system of heating and ventilation; therefore, it is wished that the statements herein presented may be not only read, but patiently studied, by those who may receive this circular.

IRA J. ORDWAY,

President of the Chicago Heating and Ventilating Company.



This cut represents our furnace as designed for school-houses and other public buildings. Its novel features cannot fail to attract general attention. Four fifteen-inch heating-flues, constructed in the form of a triangle, traverse three sides of the combustion-chamber.i An mmense volume of air enters at the bottom of these, passing over their inner heating-surfaces, is warmed and then sent into the rooms, thus rapidly changing the air-supply.

The idea of constructing this salamander-heater, was suggested by the steam-boilers manufactured by the Babcock and Wilcox Co., 30 Cortland St., New-York. These boilers are constructed also on the heating-flue plan. To Mr. Babcock, the President of this Company, we are indebted for practical suggestions and much other valuable aid. We would advise any parties who are interested in generating steam to be used as power, to visit the works of the South-Side Street Car Co., in Chicago, where they will find these boilers producing the steam for moving the Cable Cars of that Co. Pullman's works, the American Glucose Co., and many other large manufactories use the world-renowned Babcock and Wilcox Boilers.

INTRODUCTORY.

A company of eight business and scientific men lately met in Chicago to discuss the necessity of applying some new and approved methods of heating and ventilation to private residences and public buildings. It was stated by them that many people, particularly in our villages and cities, are beginning to realize how uncomfortable and unhealthy is the prevailing use of the radiation of heat, produced generally by stoves and sometimes by steam-coils or radiators set in the rooms to be warmed, with no special arrangements for the constant supply of fresh air and the constant removal of foul air from these rooms. There were noticed some defects in the present systems of heating by furnaces and steam-boilers located in air-chambers below the rooms to be warmed,—such as raising the air to a higher temperature than is needed, the improper distribution of the warm air, the consequent banking of this air on the side of a room opposite the wind, the occasional descent of cold air in an outgoing-flue and in fact through the register into the furnace, and the failure of many devices for conveying away completely the carbonic acid and the other impurities contained in the air of our buildings.

These men admitted that, while they had carefully observed some phases of the subject, they had yet to learn some important facts concerning the properties of the atmosphere, its relations to the laws and the products of respiration, its adequate control in the houses, stores, workshops, and public edifices of the people, and its proper heating by the most efficient and economical means. As undoubtedly many other persons are desirous of obtaining such information, the attempt is made, by the publication of this circular, to furnish them with some valuable items upon these subjects.

COMPOSITION AND OFFICE OF ORDINARY AIR.

The assertion is hardly needed that air is a material substance, usually seven hundred and seventy-three times lighter, at the surface of the earth, than water of the same volume. It presses with the weight of nearly fifteen pounds upon every square inch at that surface, and has the most ready capacity of expansion by heat and of contraction by cold.

Ordinary air is composed of nearly 2,100 parts of oxygen, 7,900 parts of nitrogen, and three parts of carbonic acid, in every 10,000 parts. To these must be added varying quantities of watery vapor, organic matter, and other chemical compounds scarcely discernible.

Relation of Oxygen to Respiration.

The chief office of the atmosphere as related to human beings is to furnish largely the oxygen needed for the purpose of sustaining their lives. To them having the respiratory process in a very active condition, the absence of this element, as is well known, results in their death in a few minutes; and the supply of it below the normal standard results in their languor, sleepiness, and injury to the vital organs. Air enters through the lungs directly into the blood, in which it is carried to all parts of the body, uniting with the waste particles of the latter, and forming such excretions as carbonic acid and water. By these combinations, it maintains the constant temperature of the body at about 100° Fahr.

Amount of Pure Air for an Adult Man.

An adult man, performing little or no labor, breathes from thirteen to fifteen times a minute, admitting into his lungs, at each inspiration, nearly 30 cubic inches of air. Thus, there pass through his lungs 604,800 cubic inches, or 350 cubic feet, of air in 24 hours, yielding up to his blood, during that time, about 10,000 grains, or 1 3-7 lbs. avoirdupois, of oxygen. This amount is greater by 2,000 grains than the solid dry food required to support his life and to maintain his strength during the same time. According to the lowest reliable estimates, less than 23,000 cubic feet of pure air, supplied to this man per day, will become so vitiated by his respiration and the exhalations of his skin, that it will prove highly deleterious. General Morin, a French authority of great weight, insists that this amount should range from 29,640 to 50,880 cubic feet, according to the character of the work performed in the buildings ventilated. Dr. Billings, in his admirable treatise on The Principles of Ventilation and Heating, states:—"I would advise that heating-surface, foul and fresh air-flues and registers be provided for an air-supply of one cubic foot per second per head for rooms which are to be occupied constantly. When the room is to be occupied but three or four hours at a time, and is thoroughly aired in the interval, the amount may be reduced to 2,500 cubic feet per hour, or three-quarters of a foot per second." At least 300 cubic feet of well-ventilated space are required per individual in a common lodging or tenement-house; 250 cubic feet in a school-room; 600 cubic feet in an ordinary workshop; and 1,000 cubic feet in a hospital ward.

Purifying Effects of Fresh Air.

Another important office of fresh air consists in its purifying agency. It aids in destroying, by oxidation, the noxious gases and vapors found in our buildings, and emanating from numerous sources. This action is accelerated by the influence of heat and by the formation of regular currents in the atmosphere. It is also assisted very materially by direct sunlight. It is greatly retarded by the removal of the oxygen, as the consequence of the repeated breathing of the confined air of a room.

IMPURE AIR AND ITS INJURIOUS EFFECTS.

AIR once respired loses five per cent of its oxygen, *i. e.*, there are exhausted about 100 parts of the 2,100 of oxygen in 10,000 parts of pure air; and it gains 5 per cent of carbonic acid. In other words, a cubic foot of ordinary air contains less than a cubic inch of the latter gas; but when breathed a single time, it contains upwards of 70 cubic inches. Of the 350 cubic feet of air passing through the lungs of an average-sized man in 24 hours, 17 cubic feet are converted into this gas, taking the place of an equal volume of oxygen.

Effects of Carbonic Acid.

While carbonic acid is not directly poisonous, yet air charged with more than the common amount of it, first disturbs the functions of respiration and circulation of the blood; and then soon weakens the muscles, deranges the action of the nerves, and stupefies the brain. These ill effects are seen in the weary, listless, and painful feelings experienced by those living in close, unventilated rooms. It is estimated by the best authorities, that one-half of the working force of a person is lost when breathing air which contains at least from six to ten parts of this gas in 10,000, and which has been deprived of an equal portion of oxygen. "In a school or other considerable assembly of people, the purity of the air may be pretty accurately measured by the amount of cheerfulness, activity, and lively interest, which pervades it."

Such foul air is also a frightful source of weak or diseased eyes, caused by the rush of blood to the brain, and of nervous headaches, dyspepsia, sleeplessness, scrofula, and consumption. These results are so obvious that they need only be mentioned. From two-thirds to three-fourths of our diseases are occasioned directly or indirectly by foul air. Death by quick asphyxiation is produced by breathing air which contains ten per cent of carbonic acid.

Decaying Animal Matter.

In air which has once entered the lungs, is always discovered a quantity of animal matter in a highly-decomposable state. The portion of this matter derived each day from a single human body through respiration and exhalations from the skin, varies from 100 to 240 grains, according to the degree of the activity of that body. The fetid odor of our dwellings,—particularly our bed-rooms, of our school-houses, and our frequently-crowded halls, is due to the floating molecules of worn-out, dead animal tissues. The presence of one part of carbonic acid in 1,000 of expired air, indicates the existence of these organic emanations in an amount plainly perceptible to the senses, and positively injurious to the health. Some of these molecules are occasionally the germs of contagious diseases. But reliance should not be placed upon the sense of smell or that of sight to detect the presence, in dangerous proportions, of these impuri-

ties or other poisonous contaminations of the air. This fact should be determined by the conditions which always produce such effete matter. It should also be known that heat destroys animal matter, and that no amount of diluting the air which contains such matter, ever destroys it, or renders it innocuous. The effects of "the inhalation of such vitiated atmosphere for three or four hours," says a celebrated physician, "produce in men decided febrile symptoms, higher temperature, quickened pulse, fevered tongue, loss of appetite, and thirst, even twenty-four or forty-eight hours subsequent."

Moisture from the Lungs and Skin.

Connected with the bodily effluvia, is the daily excretion of a pint of water in the form of vapor from the lungs, and of twice that amount from the skin, of a person weighing 154 lbs. and not engaged in active exercise. This vapor is diffused through the atmosphere of our inhabited rooms, and carries with it broken cells of the skin, fatty matters, and other decaying particles of the body. Air completely saturated with this moisture from any source, as is always the case when once respired, "acts injuriously upon the system; for it is unable to relieve further the skin and the lungs of the watery vapor that is constantly seeking a means of escape. There follows the feeling of oppression and languor, which even the most robust often realize in close and sultry days. By this obstruction of insensible perspiration, not only are the waste matters generated in the system unduly retained, but miasms introduced through the lungs by respiration are prevented from escaping. Moisture, joined with warmth, has a relaxing and weakening influence upon the body." It also tends to lower and dispirit the mind. Such damp air, when cold, produces penetrating and chilling sensations, which result often in influenza, sore throats, and bronchial affections.

Other Sources of Foul Air.

The air in our buildings is liable to be rendered more or less impure by the noxious gases and vapors which escape from cellars, from porous ground underneath, and sometimes from adjacent sewers and cess-pools. As is well known, such diseases as diarrhea, dystentery, typhus and typhoid fevers, and diphtheria, originate from these exhalations. They often aid in the spread of the epidemic diseases.

VENTILATION.

The object of ventilation is to preserve the normal purity of the air in our dwellings, school-rooms, workshops, churches, and other places of similar character. This can be effected only by causing the complete and quite rapid outgress of the confined air in such buildings, and the sufficient supply of fresh air, either cold or warm. When external air, as admitted into our rooms, is warm enough to

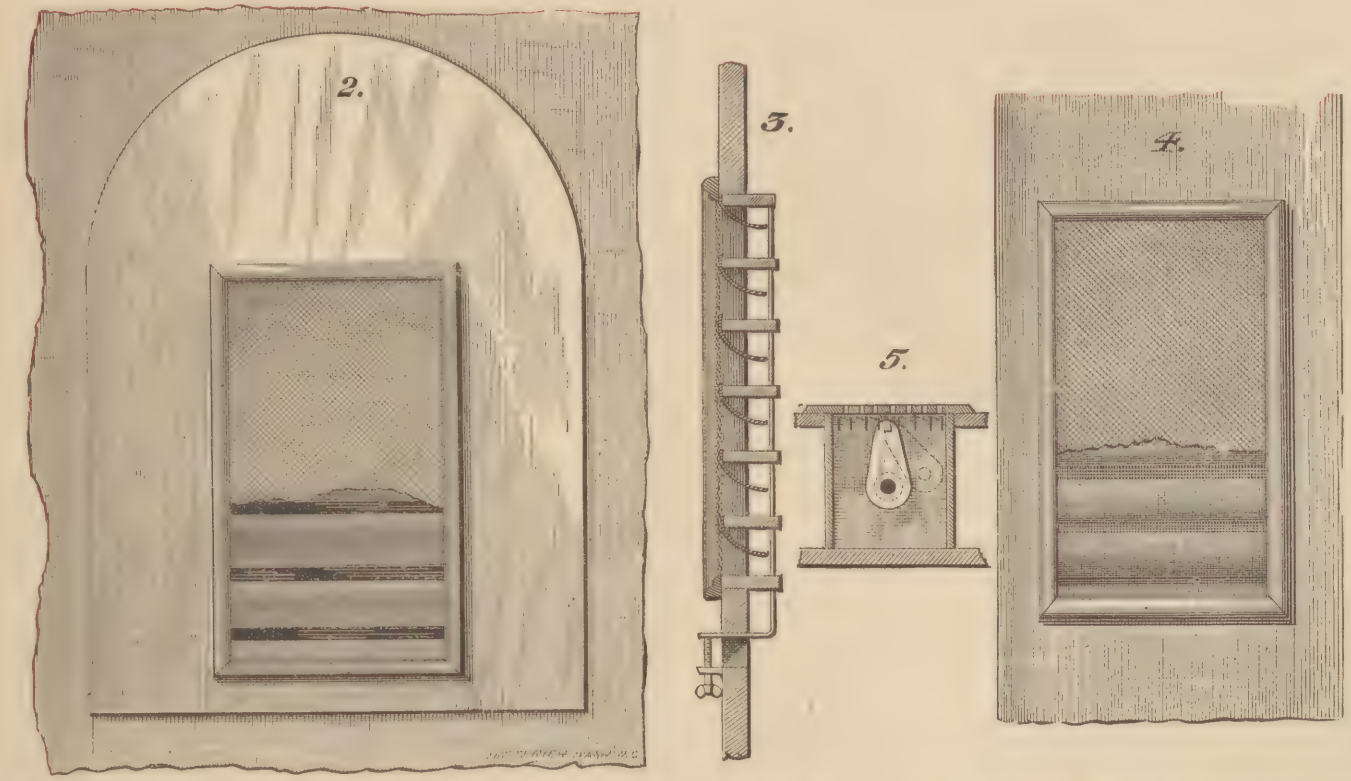


Figure No. 2 shows one of our Patent Ventilators placed in a fire-board; and Figure No. 4, in a ventilating-flue. Figure No. 3 shows a sectional view of the ventilator. The flexible valves are blown open when the air passes from the room into the flue, but are closed at any movement of air in the flue, from the opposite direction. Thus are prevented all down currents, and the consequent dust and other annoyances. Figure 5 is the end view of register-box, and shows the dish which is operated by the opening and closing of the register. This enables the occupants of the room to force ventilation during the night or any other time desired, by simply closing the register.

make their inmates comfortable, then adequate ventilation may generally be secured through windows and doors. No dependence, however, can be placed, during cool weather, upon these openings for a proper exchange between the fresh air outside and the foul air inside.

Ventilation through mechanical contrivances, needs not be here discussed. Heat is the only agency that is extensively used to bring about this end, in creating steady and sufficient inflowing and outflowing currents of air through good-sized flues. The only caution to be observed is that the movement of air in contact with the bodies of persons in the rooms, shall not be faster than two feet per second. Any rate greater than this is perceptible; and when the temperature is below 75° Fahr., the draught is usually quite injurious. It is said to slay then like a sword.

HEATING.

By Steam-Pipes or Steam-Coils.

Heating by the means of steam is comparatively expensive, whether direct or indirect heat is used. Apparatus for this purpose costs in general twice as much as furnaces which supply warm air. Its parts are more liable to need repairing, and its operation is more uncertain, meeting, as it always does, with a greater number of hinderances, as breakage, bursting of pipes, and stoppage of valves. It is frequently used for the reason, that it is seldom liable to overheat the air passing over its surface; yet furnaces heated by wood or coal can be so constructed and managed that they will raise the air to no higher temperature. The arrangement for the ingress of fresh air warmed by indirect radiation, *i. e.*, by furnaces or steam-pipes in air-chambers apart from the room to be warmed, and the exhaustion of contaminated air from buildings, are generally, though not necessarily, very defective, or else are wanting altogether on account of the great expense involved. Besides, too much moisture, in a highly-heated and vicious state, very often finds its way into the room by the leakage of steam, whichever method of heating may be used.

By Fire-Place or Open Grate.

For the purpose of warming the air, the fire-place and the open grateare the least economical. They waste heat in the greatest degree, while they secure a ventilation imperfect and unsatisfactory. Not often over 14 per cent of the heat is utilized in warming the air of a room; and under the very best possible conditions, it never exceeds 35 per cent. Dr. Billings says, "An open fire-place wastes from seventy-five to ninety per cent of the fuel consumed in it , so far as the work of warming the room is concerned." The cold air from every aperture or crevice of the room, is drawn along near the floor, around the bodies, particularly the legs and the feet of the inmates, toward the fire, and escapes mainly up the chimney. The temperature of the air in different parts of the room, varies considerably, being too warm

near the fire and often chilly by the outside walls. For these two reasons, this method is uncomfortable, and a fruitful source of colds, nervous irritability, and influenza.

By Stoves.

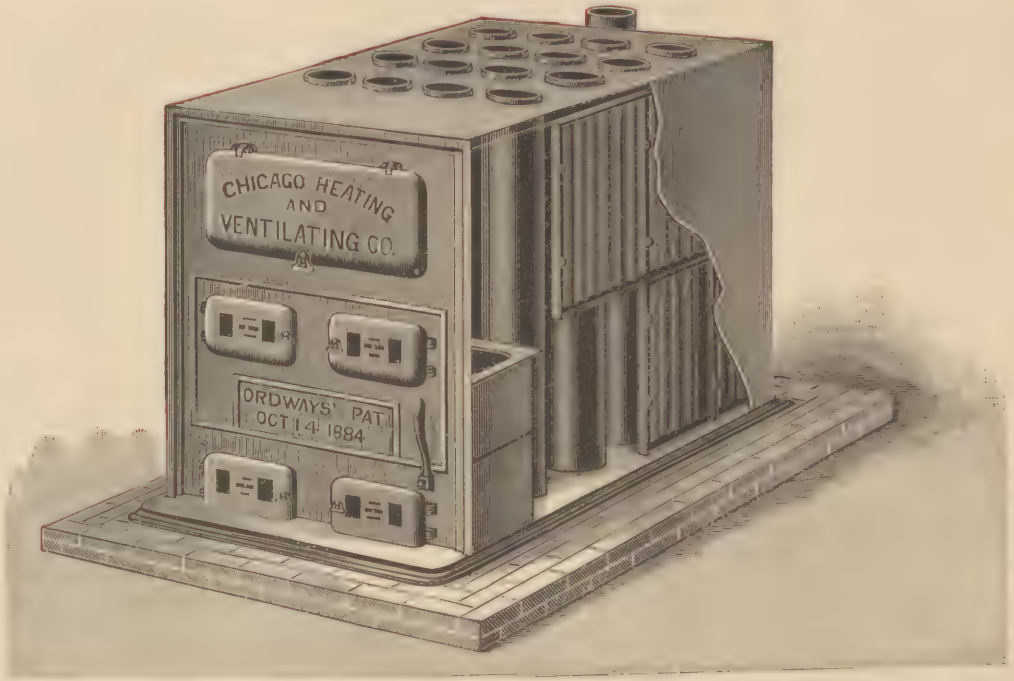
The ordinary stoves for wood or coal are procured for less money than steam-heaters, ventilating-furnaces, or fire-places. Their greatest defects consist in not supplying any sufficient means for forcing the foul air out of an inhabited apartment, and for replenishing with pure air, warmed and thoroughly circulated in all its parts. Even when connected with flues for admitting and discharging air, they do not effect an entire displacement in less than ten hours. They do not distribute uniformly the heated air in a room. More or less of the atmosphere in the corners remote from the stoves, becomes stagnant and filthy before it is removed. The temperature at different heights is registered as having the difference of 18° to 20° Fahr., under the most favorable circumstances. The larger amount of heat utilized from stoves tightly closed, is no fit compensation for the discomfort and the unhealthiness of the rooms in which they are placed. These observations apply with equal force to the use of steam-coils and so-called radiators set in our inhabited rooms or public buildings.

It should be understood that the equalized temperature of a room is attained very largely through the convection or the circulation of the air, and not by the direct radiation of the heat from the stoves. "Only the thinnest film of air can possibly be in contact with the surface of a stove at any instance in time, and yet it is only by contact that the air is heated." For "air is nearly a perfect non-conductor of heat, as one particle of air does not, or at least very slowly receives heat from another particle. Air permits the transmission of radiated heat without absorbing it." The stove is designed chiefly for radiation, and fails in securing distribution of air. This is wholly the case with steam-pipes or radiators used in a room. The apparatus which effects this equalized temperature of the air, uniformly and continually, must be the most practical and successful one.

By Our Improved Furnace.

We believe our system of heating and ventilation of buildings to be in conformity with the principle as above defined. It warms the room by sending into it large currents of air, which are warmed by passing over the immense heating-surface of our Patent Improved Iron Furnace, and then displace the air in the room by sending it into spacious outgoing-flues.

We now proceed to describe more particularly our improvements in heating and ventilation. We present these under the following heads:— (1) Our System; (2) Wherein furnace-heating has faild; (3) Construction of buildings with an arrangement for heating and ventilating each room in them by itself; (4) Application of our improvements to buildings already constructed; (5) Descriptionof our furnaces and ventilators; (6) Introduction of warm air from the furnace directly into the ventilating-flue: (7) Advantages of our two systems combined.



In our furnace above represented, a larger portion of the outer casing is removed. A smaller portion of the inner is cut away, so as to show the positions of a fire-pot, some of the heating-flues, and the diaphragm within the combustion-chamber. This furnace is provided with two such pots and sixteen such flues. It has 245 feet of heating-surface, not including that of the fire-pots. The latter should never be used in any system of warming buildings, for the reason that it is liable to overheat or burn the air to be breathed. Our heating-surface consists of plates or cylinders of iron, on one side of which the flame or burning gases come in contact, and on the other side the air to be heated. This furnace can be construced with eight to twenty heating-flues, according to the number of rooms to be warmed and ventilated. While two fire-pots are recommended in most cases, only one is inserted when so desired. These pots can be adapted to the use of wood, hard or soft coal. Attention is called to our double casing. No other furnace is made with such a contrivance. It aids greatly in saving fuel; for it utilizes not only the heat generated within the inner casing of the combustion-chamber, but all the heat radiated without this casing.

OUR SYSTEM.

OUR method of heating and ventilation embraces two distinct systems, which can be used interchangeably at the will of the occupants of each room.

First, The air is taken from the room and sent to the furnace, where its impurities are destroyed; and it is then thoroughly warmed and returned to the same room, without being mingled with air from any other room. This *revolving* of heated air may be carried on continuously, or until the room is perfectly warmed.

Second, The air is taken from outdoors, and sent to the furnace, where it is warmed, and then directed into the room, removing cold, foul air from the room through the ventilating-flue.

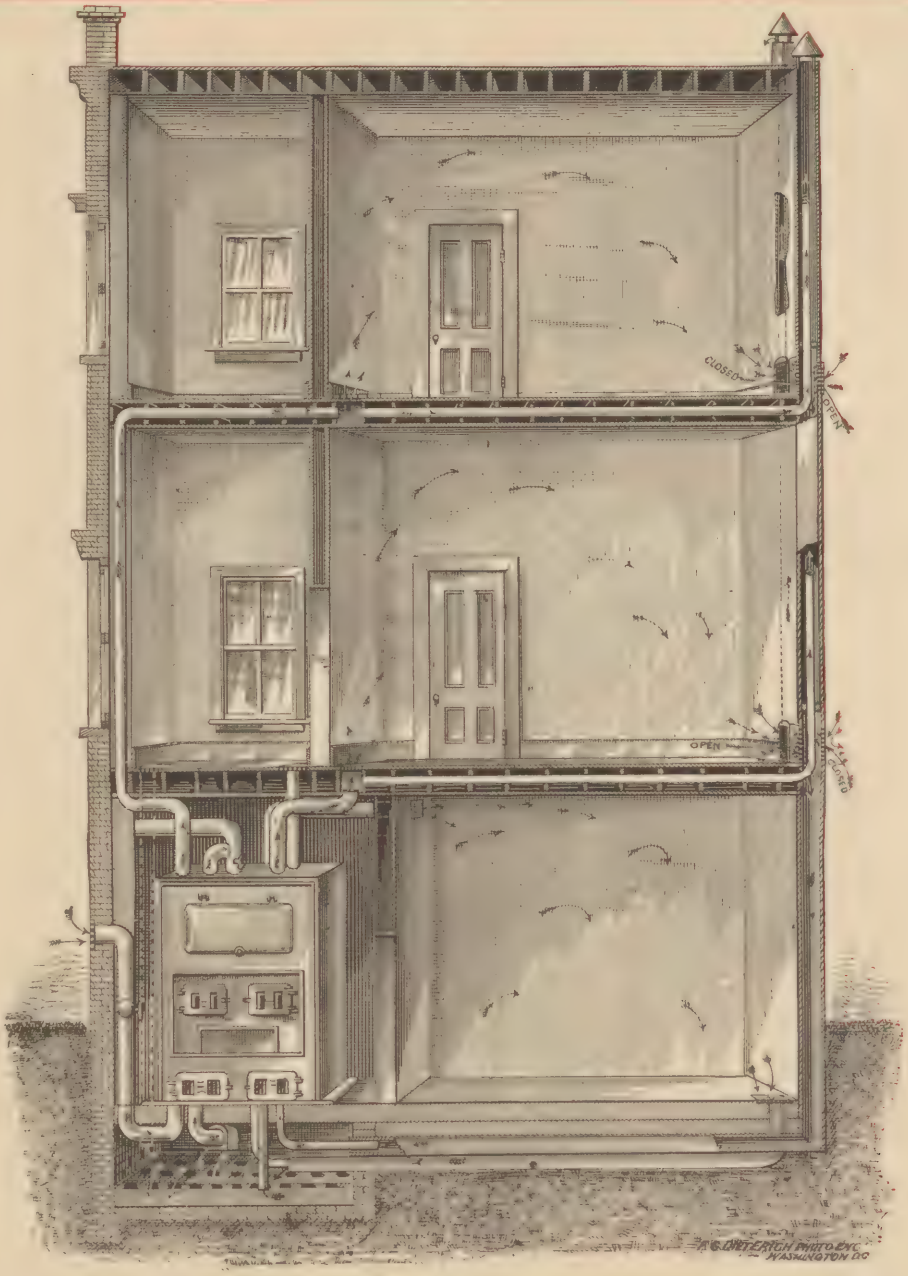
The language of our Patent is: "This invention has for its object to provide a system of heating and ventilating buildings by heated air, whereby the impurities of the heated and breathed air may be eliminated therefrom, and the surplus heat of said air be economized by retaining the partially-cooled air to be reheated; or, instead of purifying and reheating the used air, it may be allowed to escape, and cold fresh air from without may be supplied to the heater, at the will of the occupant of the house, according to the degree of heat required.

"The invention has, also, for its object to insulate the circulated heating-air of each room of a house, from that of every other room, instead of supplying each room with air from a common drum or reservoir, which is replenished with air returned from the several rooms of the house; as is ordinarily done when a complete circulation of air is employed.

"Each room is accordingly provided with a complete and independent heating-apparatus, which has nothing in common with that of another room, except the heating-furnace through which the air-flues lead, and to which the eliminated impurities of the reheated air are fed; and each apparatus is provided with a number of inlet and outlet registers, located in the proper room, or within easy reach of the occupant thereof; so that the heating and the ventilation of said room may be effected, at the will of its occupant, by a continuous circulation of reheated air, or by the passage of separately-heated fresh air, or by the combined effect of both."

Another important point in our system consists in the ability to warm completely all portions of a building, whatever may be the conditions of the air outside. This can not be prevented by any slight difference in the temperature of the air within the building and the air without, nor by any opposing currents of the external air; as the draught under the furnace is so strong as to overcome easily all such hinderances. Dr. Billings says very pertinently, "We must make sure first of having satisfactory heating arrangements in our building; and having done this, must make the plan of ventilation correspond to the particular method of heating adopted." In fact, the heating is "the more desirable and necessary; since without it, the better the ventilation the louder will be the complaints."

We shall proceed, farther on, to present separately each feature of our method; but before doing so, we wish to show why previous systems have failed, that the reader may be able to understand the superiority of ours.



The above engraving represents our system in full working order. The room in the basement is heated by introducing warm air at its top, and by exhausting cold air from its bottom. It will be warmed as comfortably as any other room in the house, when the doors and windows are closed.

The room on the first floor is represented as being heated by revolving the air; i. e. by sending the air down into the furnace, and then returning it to the same room. It is provided, the same as the other rooms, with cold-air flues which lead from the room itself and from the outer air down to the furnace. Take notice that the register on the outside of the room is "closed" while the one on the inside is "open".

In the upper room, the operation is reversed, the inside one being marked "closed" and the outside one "open." In this case, the cold and foul air is sent outdoors through the ventilating-flue, by our patent method of artifical aspiration, which is explained elsewhere in this work.

It will be observed that the hall has also attached to itself the double system of moving the air. The air from the hall is returned under the heater, or air from outdoors is introduced into the furnace, as is shown; and then it is heated by being passed between the two casings of the furnace, thus utilizing the heat that otherwise would be lost. The two-chambered reservoir beneath the furnace, shows how the lowest and heaviest air is employed in burning the gases in the furnace. A leak-passage allows the heavy air to enter the foul-air chamber from which it is taken into the combustion-chamber to consume the gases. This cut also shows the pipe that conducts the warm air from the register-box into the ventilating-flue in order to force ventilation whenever necessary.

WHEREIN FURNACE-HEATING HAS FAILED.

FURNACES for warming buildings have, without exception, been constructed on the plan of heating the air in a common chamber, from which the air has been conducted by flues to the different rooms to be heated. The air supplied to the furnace is generally taken from outdoors through what is termed a "cold-air duct." In a small number of instances, the air has been returned to the furnace from the hall or other parts of the house; and this plan has always been found an improvement so far as heating is concerned, but objectionable in the quality of the air furnished the occupants. Under such unfavorable circumstances, it is indeed strange that furnace-heating has succeeded in anywise; but warming, by this means, the air in which we live and breathe, being the *correct principle*, the system has hence attained some popularity, notwithstanding all its defects.

Furnace-men often say that "nine-tenths of the furnaces are failures," wishing to impress the purchaser with the idea that their own furnace comes within the successful "one-tenth."

EXPLANATIONS OF THESE FAILURES.

1st. A law of nature has been disregarded in trying to enclose two quantities of air in the same space at one time. The impossible effort is made, by the introduction of hot air, to warm a room already full of air, without providing any means for the displacement of that air. To illustrate: Suppose a jug filled with cold water is to be warmed by pouring hot water into it. This result can not be reached without first removing some of the cold water, thus making room for the introduction of the hot water.

The plumber understands this principle, when he connects the boiler with the water-front of the range. He joins the former, a tall and slim cylinder, with the latter by two pipes, one leading down to the bottom, and the other toward the top of the cylinder. The water is thus rapidly heated by circulating through the water-front.

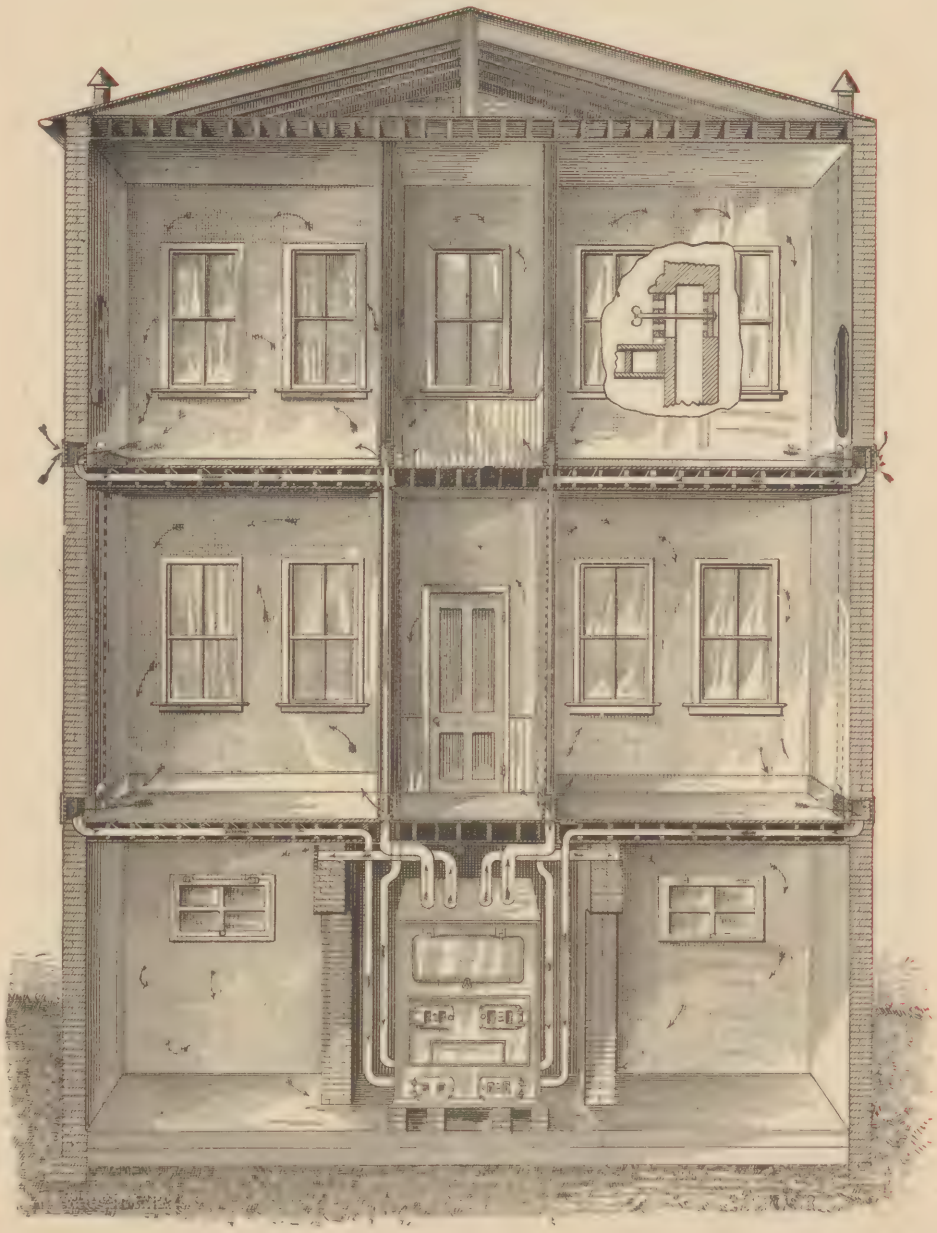
Since gases can not be annihilated any more than fluids, a room containing cold air, in order to receive warm air promptly and effectually, must be furnished with a sufficient opening for the rapid escape of the cold air, and generally with some means employed for forcing ventilation.

FURNACE WITH A COMMON CHAMBER.

2nd. *All furnaces heretofore have been constructed with a common air-chamber.*

This has always been a most fruitful source of trouble. When several rooms are warmed by a single furnace, one register usually draws against others, interfering with the currents of air sent through them. Registers nearest the furnace and those set in the upright stacks exhaust the supply which should be directed to the more remote ones.

The momentum of the warm air is greatly retarded by being broken and checked in a common drum. The currents are broken by coming in contact with each other, and with the top and sides of the drum. They are also checked by being directed into



The above cut shows some of the various ways in which both the warm-air and cold-air flues can be arranged in a building. In wooden buildings the space between the studs can be occupied by these flues. In both wooden and brick buildings the space between the joists can be occupied in the same way. In a majority of the houses already built, boxes in their basements can be constructed to accomplish the purpose which is had in view in the above-mentioned arrangements. We shall always be glad to consult with parties in trouble in regard to heating their buildings.

In the broken space of the third story, are represented the inside and the outside registers, with their attachments so fixed that when one is closed the other is open.

separate flues, thus retarding the motion and diminishing the quantity of air delivered. The pressure or "head" is also largely destroyed by these irregular and conflicting currents, causing the air-flues to convey away the warm air sluggishly. None of these difficulties exist in the heating and delivering of air in a continuous flue.

If the supply of air is taken exclusively from the hall or any other part of the dwelling-house, the smoking-room and the sick-room send their disgusting odors and the seeds of disease to all other parts of the house.

So offensive and harmful has this latter system become, that scientists and State Boards of Health have endeavored to secure its prohibition by law.

Want of Displacement.

3rd. Want of means for removing air from inhabited rooms.

More than three-fourths of our buildings contain no provisions for ventilation, except by the opening of windows and doors. In cold weather, these are of no practical use for this purpose, since when a door is ajar or a window lowered, the outer air, being heavier, rushes in, instead of the inside warm and foul air going out. Even when regular ventilating-flues are constructed, in the time of a gale or extremely low temperature of the weather, the air is often forced down such flues, adding difficulties even more formidable than in the previous cases.

Conclusion.

4th. We conclude that the failures of furnace-heating are not due to the want of capacity in the furnaces to heat, but because the proper forms of the ventilating or displacement-flues are not provided, and the furnaces are not designed with appropriate arrangements for using them.

It is this same cause which has baffled the advocates of indirect steam-heating systems, and forced them to introduce generally the pernicious devices called "radiators" (should be called conductors) into apartments to be heated. More than the common stove, as we have shown, these "steam-radiators" destroy the purity of the confined air, causing the inmate of a room so warmed to relieve his sufferings, for the want of more oxygen, by lowering a window, until the cold chills run down his neck and back.

> " If cold air reach you through a hole,
> Go make your will and mind your soul."

Our public buildings are largely heated by such direct radiators; and their small compartments are unsafe unless the doors and windows are kept well open. And still this method of ventilation is very imperfect, and causes frequently great injury to the health of those subjected to the draughts of air from these doors and windows.

Therefore, we say again that want of displacement is the principal cause of failures in introducing heaven's pure air, warmed for our comfort and health.

Having thus defined our system, and set forth the difficulties of other methods, we proceed to describe more particularly the details of our own, which is covered by Letters Patent in all its parts.

CONSTRUCTION OF BUILDINGS.

A building should be designed with a separate flue for each room to be heated, through which the air of the room can be conducted back to the furnace. This flue should be connected with both the air in the room and the air outside. Also, the room should have an outgoing shaft, for the purpose of removing the air from the room when the outside air is used.

For sizes and location of such flues, architects and others interested in the erection of buildings are kindly requested to submit their plans to us. Our services for advice and instructions in such cases will be free.

BUILDINGS ALREADY FINISHED.

We are often asked the question, "Can your combined systems of using inside and outside air be applied to buildings already erected?" While we answer in the affirmative, we know that it is difficult to give directions which will apply to all cases.

Flues can be attached on either the outside or the inside of buildings, so that every room in them can be warmed and ventilated as completely as if the buildings had been first constructed in accordance with our system. To effect this result is, of course, somewhat more expensive; and is so in proportion to the size of the buildings and the nature of the materials used in making the flues. In a large number of instances, such as English basement-houses, where the basement is used partly or wholly for furnace and for storage of coal and other articles, the lower rooms can readily be heated by our combined systems. In this case, the flues are confined entirely to the basement, and the cold-air registers are placed in the floors.

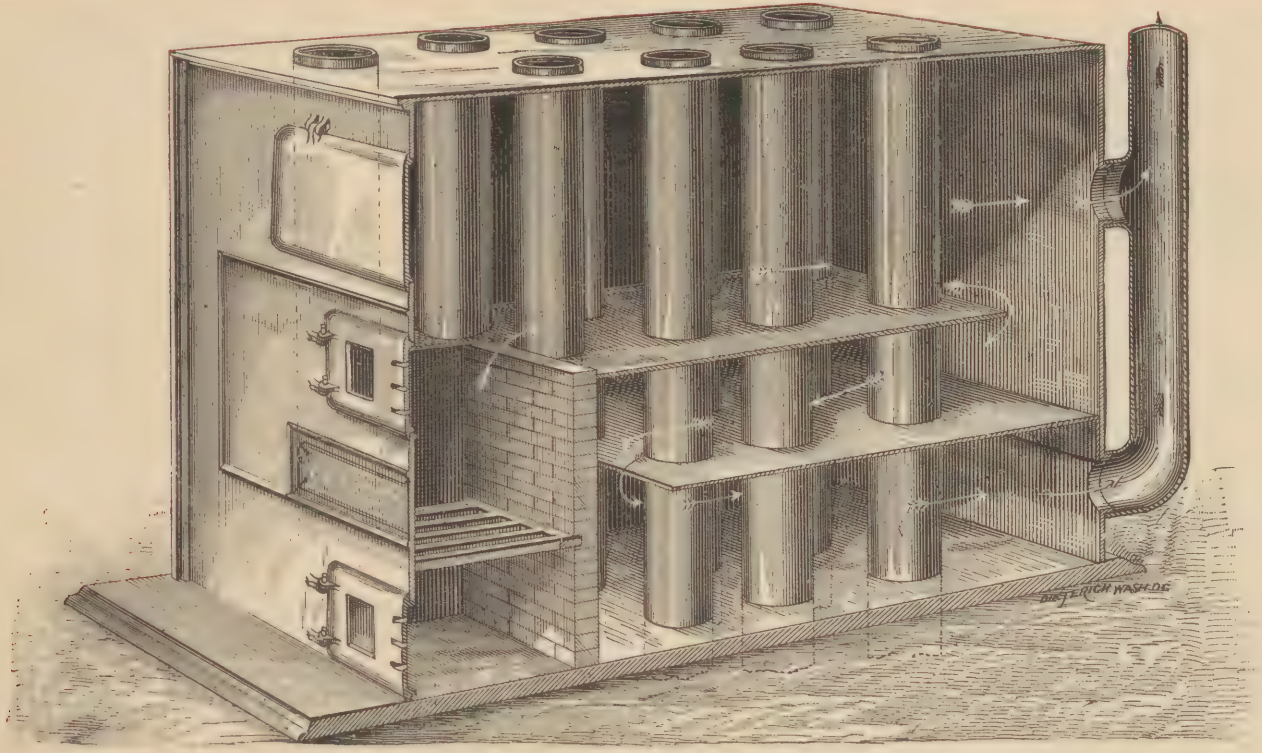
The upper part of the house can be heated by either system in the ordinary manner; and great benefit is derived from our separate-flue furnace, both in the momentum of the heated air and from the fact that each flue will deliver, through its own register, all the air heated in it; for no register, however favorably located, can rob another.

We will gladly furnish any applicant with plans and estimates of cost for these changes in buildings already finished.

CONSTRUCTION OF OUR FURNACES.

In the furnaces invented and built by us, the air for each room is warmed in an independent, large pipe. These pipes extend entirely through the fire-chamber, and are connected at the bottom with the cold-air flues which lead from the room and the outer air, and also at the top with the warm-air flues which lead to the same rooms.

Thus we have a continuous pipe or flue, with no joints in the



The above sectional view of one of our furnaces shows the movement of the flame in the combustion-chamber. The upper arrows indicate that this flame starts from the fire-pot, passes above the upper diaphragm and around the upper portion of the heating-flues or pipes, and enters at once into the smoke-pipe when its damper is open at the upper outlet. The current takes this course when the direct draught is used; as is the case in building the fire.

The middle and lower arrows indicate the direction of the flame upon closing the damper in the upper outlet. This flame passes between the two diaphragms and under the lower one, circling around the lower portions of the heating-flues, and discharging itself into the smoke-pipe through the lower outlet. This causes the flame to come in contact three times with the heating-flues. The best results are thus obtained, as the heat is very largely taken up before it reaches the lowest division of the combustion-chamber. The outlet being at the lowest and coolest part, the pressure or "head" is utilized, as well as the movement of the flame encircling the flues. A soft-coal grate is here shown. The use of soft coal saves expense and is admirable for heating.

heating-chamber, running from each room and from the external air and back to the room. The occupant is provided with the means of changing, at will by the action of registers, from inside to outside air, or using both at the same time.

A double casing entirely enveloping the fire-chamber, enables the heat communicated to the outer wall of this chamber to be wholly utilized.

No other heating-furnace is made without joints in the fire-chamber.

In our furnaces, the flame is sent three times across the pipes or flues, and the smoke is exhausted near the bottom, at the coolest part, allowing the heat to be retained in the fire-chamber.

The furnace is provided with a rocking grate, which breaks up and dumps the clinkers, and is worked by a lever without opening a door, thus insuring the operator and the furnace-room against dust from this source.

One of our furnaces will last for many years, excepting the fire-pot; and this can be replaced through the fire-door, not subjecting the purchaser to the dust, annoyance, and expense of taking the furnace apart when such repairs are made.

Our large-sized furnace is provided with two fire-pots, thus becoming a powerful heater in cold weather when both are used. In mild weather, the fire needs be started in only one of these.

By these contrivances, we conform to the test signs of the best furnaces, which, as stated by an excellent authority, embrace those patterns "having the fewest joints and the largest amount of radiating surface in proportion to the size of the fire-box." He adds, "It is very poor economy to buy a furnace which is not large enough to furnish, in the coldest weather, all the heat required, without heating the fire-pot to a red heat."

VENTILATORS.

OUR Patent Ventilators can be applied to any aspirating or ventilating-flue. They are constructed so as to allow the air to escape through them into such a flue, but they prevent air returning through them into the room. Thus they immediately stop all down draughts, as well as contrary pressure of air in the room and the introduction of dust. When descending currents of air are allowed to form in the ventilating-flues, the delivery of warm air from the furnace, as is well known, is greatly hindered or entirely checked. Our ventilators also indicate whether or not the proper exchange of air is in operation in the room.

WARM-AIR ASPIRATION.

OUR Patent method of introducing warm air from the furnace directly into the ventilating-flue, is entirely new, and is pronounced the most simple and effective contrivance for artificial aspiration ever devised. In most cases, we apply it by running a pipe from the register-box into the ventilating-flue; and by an attachment, we open the valve in said pipe when the register is closed,—thus sending a volume of warm air into the aspirating-shaft, and thereby forcing ventil-

ation. Different from the ordinary methods, the ventilation is kept up during the night, and at other times whenever the register is closed for the purpose of cooling the room.

As before stated, our ventilator will show when the exchange of the air in the room is suspended; and in such cases, this exchange can be recommenced by closing the register for a few seconds.

ADVANTAGES OF THE COMBINED SYSTEMS.

The reader now clearly understands that we have two complete systems of heating and ventilation; and he may ask, "Is not one of these better than the other? and if so, why not use the better all the time?" It is admitted that fresh air from outdoors, gently warmed, is the best which nature or science can provide for us to breathe and live in; but that in very cold weather, it is possible to warm, by artificial means, only limited quantities of this air.

The greater the quantity of air so warmed, the larger is the expense. While there would be no disadvantage, so far as health and pleasure are concerned, in introducing into our houses a supply of warm air sufficient to ventilate a hospital ward, the cost would be too great for the majority of the people. Thus, there is a limit to the supply and the demand in this as in other things. The revolving process is far the cheapest; and may be used in times of heavy wind and severely-cold weather, as well as in the first warming of a room, or in the preparation of it to be occupied.

Under the former circumstances, the pressure from without is so great that more outdoor air than is required is forced into the room through the walls and the loose joints. Air in the room to be heated is pure, or can easily be made so before heating; and to warm it by several revolutions through the furnace, is much better than by injecting a small quantity of highly-heated and burnt air.

In very cold weather, the air, brought from outdoors, is frequently raised from 200° to 600° Fahr., in order to heat the room sufficiently. Such superheated air is a hundred times more dangerous than the air of the room revolved several times while being warmed. Afterwards, it is best to introduce as much outdoor air as possible under the circumstances, and as can be afforded financially.

We would, however, strongly recommend the use of the outside and the inside air, combined in such proportions as will make the air and its temperature in the room both normal.

This can be accomplished by a little experience in setting the registers so that the supply is taken from both the room and the outside, in proportion to the heat and the air required.

The operation of two forces is saved by revolving the air for the purpose of causing a movement in the aspirating-shaft; viz.,

First, The pressure derived from the heated air.

Second, The establishment of currents in the room. The revolving of the air gives the most complete circulation possible, because it absolutely exhausts the air from the room, as well as forces in an abundant supply.

The cold air, entering the room through minute apertures, drops out immediately, and is not banked nor confined by the incoming warm air.

When the entire supply is taken from without, and the ventilating-flues are working properly, the air in the room is constantly and completely changed. The larger the supply of heated air, the more rapidly the volume of air in the room is changed.

We are aware that, in a large number of cases, the heating-furnaces in buildings are unsatisfactory, and that some of them are being replaced by steam-boilers. We would respectfully request all parties whose heating-apparatus is not proving satisfactory, to call on us. We will freely furnish plans, showing how to remedy the existing defects.

But we would here request the consideration of the principal disadvantages of steam-heating apparatus, stated by Dr. Billings to be as follows: (1) "It is somewhat dangerous; (2) It requires constant attention to keep up the supply of heat; for as soon as the production of steam in the boiler ceases, the radiating surfaces cool rapidly; and (3) Owing to the high temperature of steam-radiators, it is difficult to regulate the supply of heat, in accordance with the demands of our very variable climate, without interfering with the amount of air-supply. As steam-heating apparatus is usually arranged, the only way to diminish the heat is either to close the register which cuts off the supply of fresh air, or to turn off the steam from the radiator, which will give an insufficient supply of heat. The result is that the great majority of steam-heated rooms are, during many days in the year, too hot, and at the same time have an insufficient supply of fresh air."

THE IMPORTANCE OF THE REMOVAL OF FOUL AIR FROM DWELLING-HOUSES.

By W. H. Genung, Chief Inspector of Health Department, Chicago, Ill.

Adequate Ventilation Required by Law.

In 1881, at the time of the revision or amending of the general ordinances of the city of Chicago, a special meeting of the Committee on Health of the Board of Aldermen was called to consider especially the framing and the adoption of stringent laws to prevent persons from polluting or adulterating food. A member of the Department of Health suggested that these laws should include provisions against the pollution of the atmosphere "*in all habitable rooms*;" as the time was not far distant when the statutory laws would place at least a penalty upon every adult (having the power to prevent it), who permitted impure air to be or to remain in any place of habitation, and particularly the sleeping-rooms.

It is but four years since this suggestion was made; and we now find that nearly all sanitarians are looking to the framing of laws compelling the builders of houses to provide ample arrangements for heating and ventilating the same properly. This is a matter of so much importance that architects have long since made it a special study; and it is approaching an interest in their minds equal to that of plumbing and drainage.

Public Instruction Upon This Subject.

The subject of quantity and quality of the atmosphere in dwellings, is of so vital importance that the Principal of the technical high school in Berlin, Germany, has adopted the following: (1) Instruction in theoretical hygiene in all the technical schools by medical men, sufficient to enable an intelligent grasp of the general principles; (2) Instruction in the schools on those heads of hygiene technic, especially connected with architecture, building, engineering, machinery, and chemistry; (3) Hygienic instruction to be made obligatory, and to form one of the subjects for examination; (4) The collection of hygienic apparatus and material, with the establishment of a hygienic experimental institute. This is as it should be throughout the civilized world, to the end that all could know the irreparable loss by sickness and death which is caused wholly from inhaling impure and improperly-heated air in our dwellings.

Impure Air the Source of Disease.

Many of the so-called zymotic and pulmonary diseases have their origin completely in the inhalation of impure air. Common air in cities contains numberless particles of filth and other impurities, sometimes including disease-germs in their most virulent stages. All of this can be readily demonstrated under the microscope, but can not be detected with the natural observation. In other words, disease-germs, as usually found in the common atmosphere, are so small that a hundred of them can pass together through the eye of a cambric-needle. This demonstrates the necessity of supplying air to our dwellings in as pure a state as practicable, at a temperature which destroys these germs, and without being intermixed with air which has been deprived of its oxygen by exhalations from the lungs of a person in good health, or poisoned by the inmates of a sick-room. As is well known, all air containing carbonic acid and moisture derived from the lungs and skin of the human body, can not be purified by any application of heat.

The minimum of poisonous deposit in the exhalations from the lungs of an adult in good health, is equal to 8 per cent of the whole; and will render common atmosphere unfit for use to the extent of 3,500 cubic feet per hour for a person in repose. How much more would be required for persons in ill-health and in high blood-temperatures, needs not be stated. In arranging for heating and ventilating a building, the *quality* of the air to be supplied should be more fully considered than the *quantity;* because the first will regulate the latter.

Success of the Improved Plan.

The most important consideration is to prevent the intermingling of the poisoned air of one room with that of another. This is accomplished by The Chicago Heating and Ventilating Company, in the most thorough manner. In no case do their furnaces transmit the air from one room to another; but always take the air for each room through a separate supply and heating-pipe, leading to the room itself and to the outer air, and having no connection whatever with any other room or portion of the building.

WHAT THE PRESS SAYS.

The following is an extract from an article published in the *Chicago Journal of Commerce*, entitled:

A New System of Heating and Ventilation.

We herewith present our readers with a brief description of an entirely new heating and ventilating system. While the system has evidently been evolved with careful study and scientific experiment, there is yet such apparent simplicity in its construction and such tangible philosophy underlying it as to bring its uses and benefits easily within the range of general comprehension.

The system is the invention of Mr. Ira J. Ordway, of this city, who is also President of the Chicago Heating and Ventilating Company, the corporation which has the exclusive manufacture of the furnace and the ventilating apparatus, as well as the introduction of the system. The invention really embraces two distinct systems, which can be used interchangably at the will of the occupant of each room. First, The air may be taken from the room through the returning-flue and conducted to the furnace, which it enters from beneath. Here it is thoroughly warmed and purified, and sent to the same room. This revolution of heated air may be used for the first heating of the room, or carried on continuously, as desired. Second, The air may be taken from outdoors, and conducted through the furnace and into the room, the force of its current expelling at the same time, all cold and foul air through the ventilating-flue.

Their ventilators can be applied to any aspirating or ventilating-flue. They are so constructed as to allow the air to escape through them into the flue, but effectually prevent it returning into the room. By this means, all down draughts are suspended, and all contrary pressure of air, as well as the introduction of dust into the room, is prevented.

Their method of introducing warm air from the furnace directly into the ventilating-flue, is entirely new; yet it certainly appears a simple and effective contrivance for artificial ventilation. The utilization of heat is complete. By means of an inner casing to the fire-chamber, and by the exhaustion of the smoke near the bottom, the heat is wholly utilized, even to the portion which is communicated to the outer wall of the chamber. Their large furnace is provided with two portable fire-pots, only one of which needs to be used in mild weather. Each fire-pot can be removed, and replaced through the fire-door, without the expense and the annoyance of taking the furnace apart when repairs are needed. The furnace is complete in all its details. It will be seen that the system of ventilation is a perfect one, producing a current in the room, and giving a most complete circulation. While cold or foul air is being exhausted from the room, an abundant supply of pure warm air is forcing its way into the room, and of course the larger the supply of this heated air the more rapidly the volume of air in the room is changed. Thus it is seen that there can be no such thing as the banking of cold or foul air, no matter what the conditions of atmosphere may prevail on the outside. It is further apparent that a normal temperature can be maintained in a room by the combination in proper proportions, of the outside air with the inside air, which can be accomplished by a little experience in setting the registers so that the supply is taken both from the room and the outside in proportion to the heat and air required. An important advantage of the system is, that each room is provided with a complete and independent heating apparatus, which has nothing in common with that of any other room except the heating-furnace through which the air-flues lead.

By the aid of inlet and outlet registers, each room may be heated or ventilated at the will of the occupant, by a continuous circulation of reheated air, or by the passage of separately-heated air, or by the combined effect of both.

Ordinarily, furnace men are compelled to take their supply of air from the hall-way or other part of the house, especially in very cold weather; and as a matter of course, where such a common source of supply is used, nauseating and unhealthy odors are unavoidably gathered into the general circulation.

Under this system, it is claimed, with considerable show of reason, that every such deleterious effect is avoided; and that the air of one room may be kept perfectly pure, though every other apartment in the house may be a sick-room or a smoking-room. From a sanitary point of view, this advantage alone, stamps the introduction of the system, as a blessing of inestimable value.

Prof. W. C. Whitford, formerly State Superintendent of Schools, of Wisconsin, who has given years of study and research to the science of heating and ventilating public and private buildings, gives the following voluntary endorsement, in a private note to the inventor. "In my opinion you can solicit orders for your furnace with the conviction that you have devised the best heating and ventilating apparatus in existence. The more I study its features, the more clearly I am conscious of this fact."